

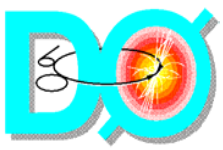


Computing & Software

Model

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DØ Finance Committee Discussion on Regional Analysis Centers
Fermilab, July 15, 2002



Trigger & DAQ



- ~ 7,000,000 collisions per second, most of them are “uninteresting”
- successive hardware and software algorithms to select interesting events for offline analyses



Rates & Sizes

Event Rate:

Assuming an overall duty factor of 50%, we are writing

- **25 events per second**
- **~800,000,000 events per year**
- **~1,600,000,000 events for Run IIa**

Bits and Bytes:

With an average size of 250 KB/event, we are writing

- **6.25 MB per second**
- **~200 TB per year**
- **~400 TB for Run IIa**

All these have to be processed and analyzed



Physics Analyses

Monte Carlo

- event generation
- detector/physics simulation
- ...

Raw Data:

- trigger system
- data acquisition
- data monitoring
- ...

Calibration

- pedestals
- gains, linearity
- ...

Reconstruction (RECO)

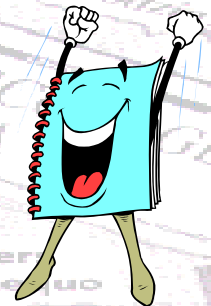
- detector algorithms
- particle identifications
- output format
- production farm
- ...

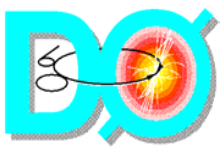
Databases
Network
Releases
Operation

Data handling & access
Trigger simulations

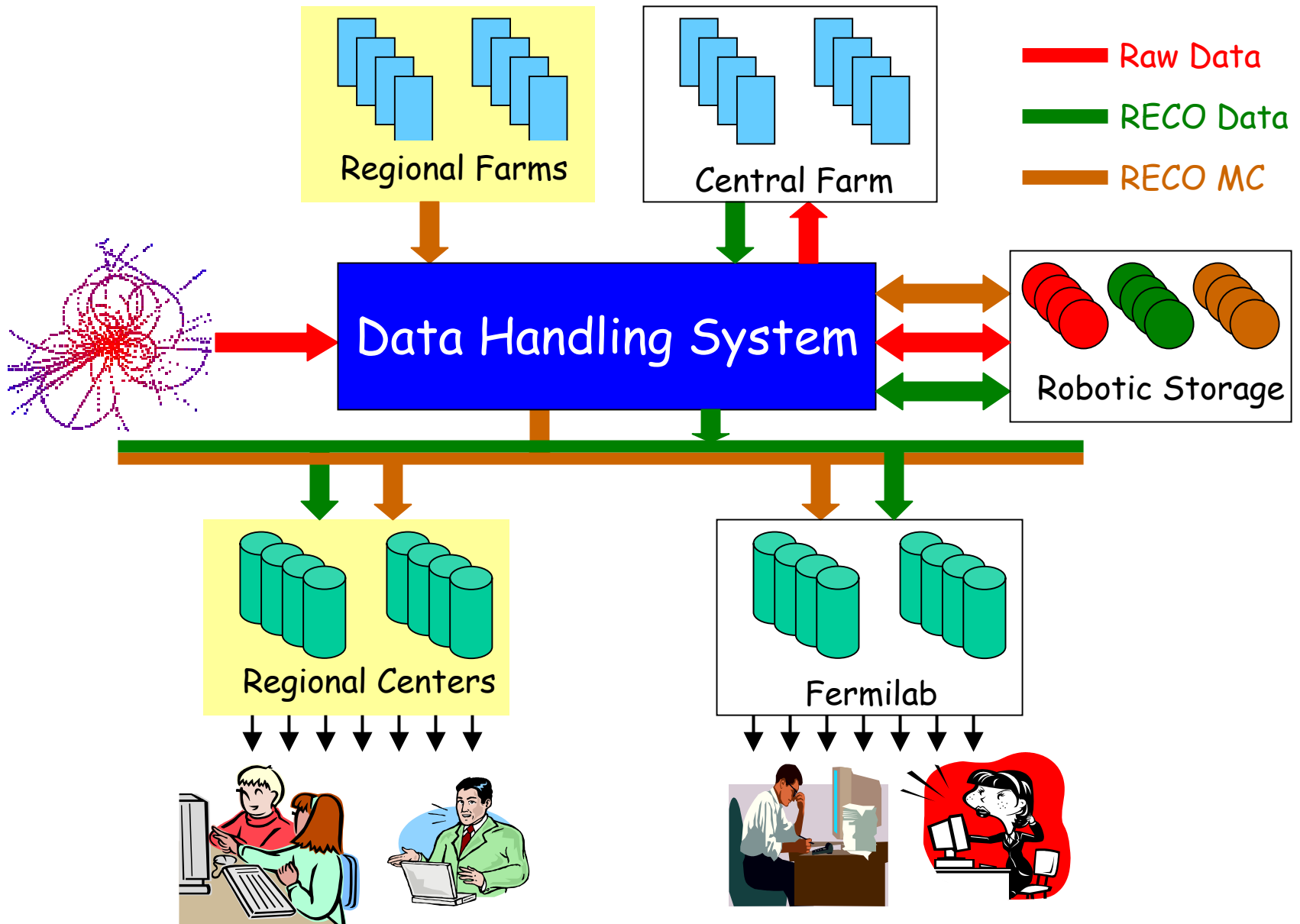
Physics Analysis

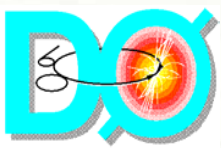
- event selections
- efficiencies & backgrounds
- ...





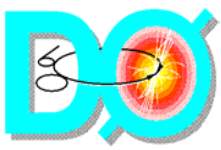
Primary Data Path





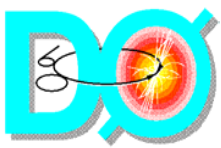
Data Production Farm

- **A PC/Linux based farm has been deployed at Fermilab to perform initial processing of the raw data**
 - **Basic functionalities: reconstructing physics object candidates from raw detector information and writing out in both DST (data summary tape) and TMB (thumbnail) formats for physics analyses**
 - **Currently the farm has 122 dual processors with a total 0.186 THz CPU power, soon to be augmented with 240 new dual processors with a total CPU power of ~1.15 THz**
 - **The farm has been keeping up with the data-taking and DØRECO. Our plan is to continue upgrading the farm to be able to fulfill all initial processing needs**
- **However, there won't be enough CPU power available for secondary processing that may be required for timely physics analyses**
 - We hope to meet some of this need with the CPU power from collaborating institutions**

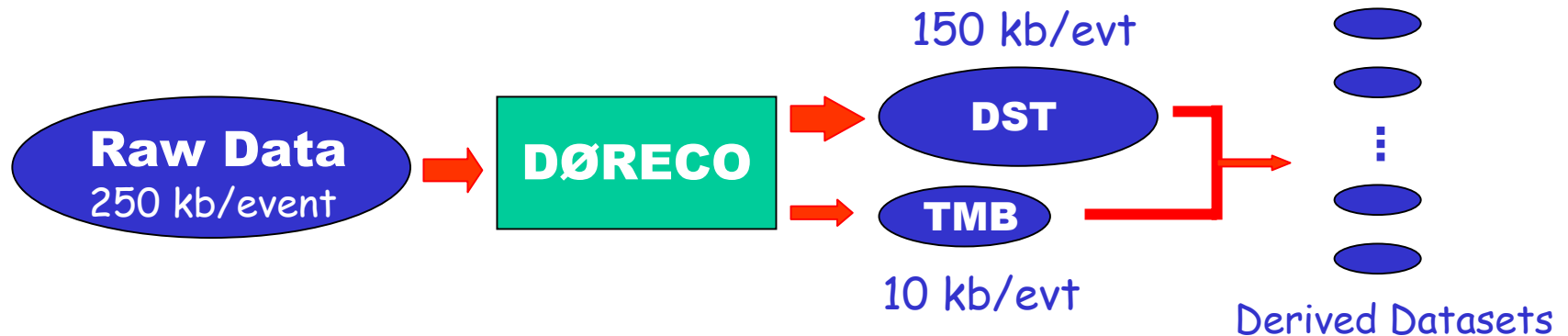


Monte Carlo Production

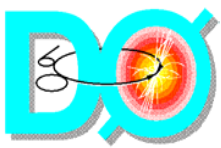
- **Simulation of detector responses and physics processes is an integral part of our physics analysis effort.**
- **To meet the analysis needs, Monte Carlo events have to be produced at $\frac{1}{2}$ of the rate of the data events.**
- **There is no resource available at Fermilab for Monte Carlo production.**
- **Remote Monte Carlo farms have been meeting our physics analysis needs so far.**
 - Current sites: Boston, CCIN2P3, Lancaster, NIKHEF, Prague, UTA, ...**
- **The total capacity of the existing farms is ~ 3 Hz. We are**
 - developing a fast simulation program for some of the analyses**
 - seeking new sites to increase our production capability**



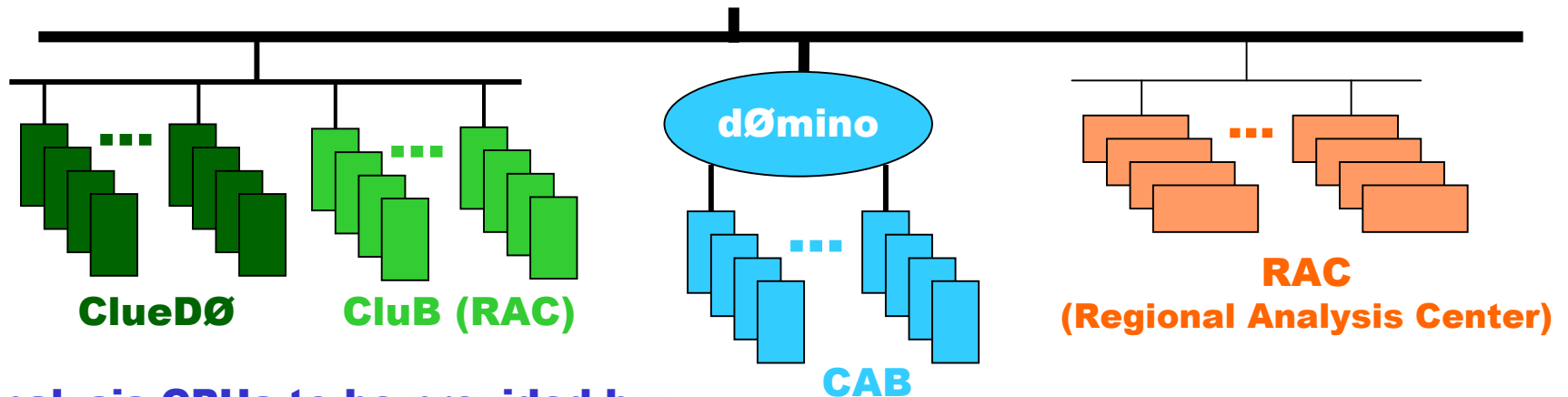
Data Tier



- **DST (Data Summary Tape):**
all high level physics objects, some detector-level information to allow calibration and limited re-reconstruction.
100% on tape, partial set on disk.
- **TMB (Thumbnail):**
all high level physics objects, good for most physics analyses,
100% on tape, 100% on disk at central and regional centers.
- **Derived Datasets:**
Physics/ID groups or their subgroups may create their derived datasets from either DST or TMB in their chosen format and are responsible for maintaining these datasets.



Analysis Model

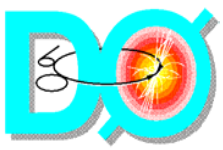


Analysis CPUs to be provided by:

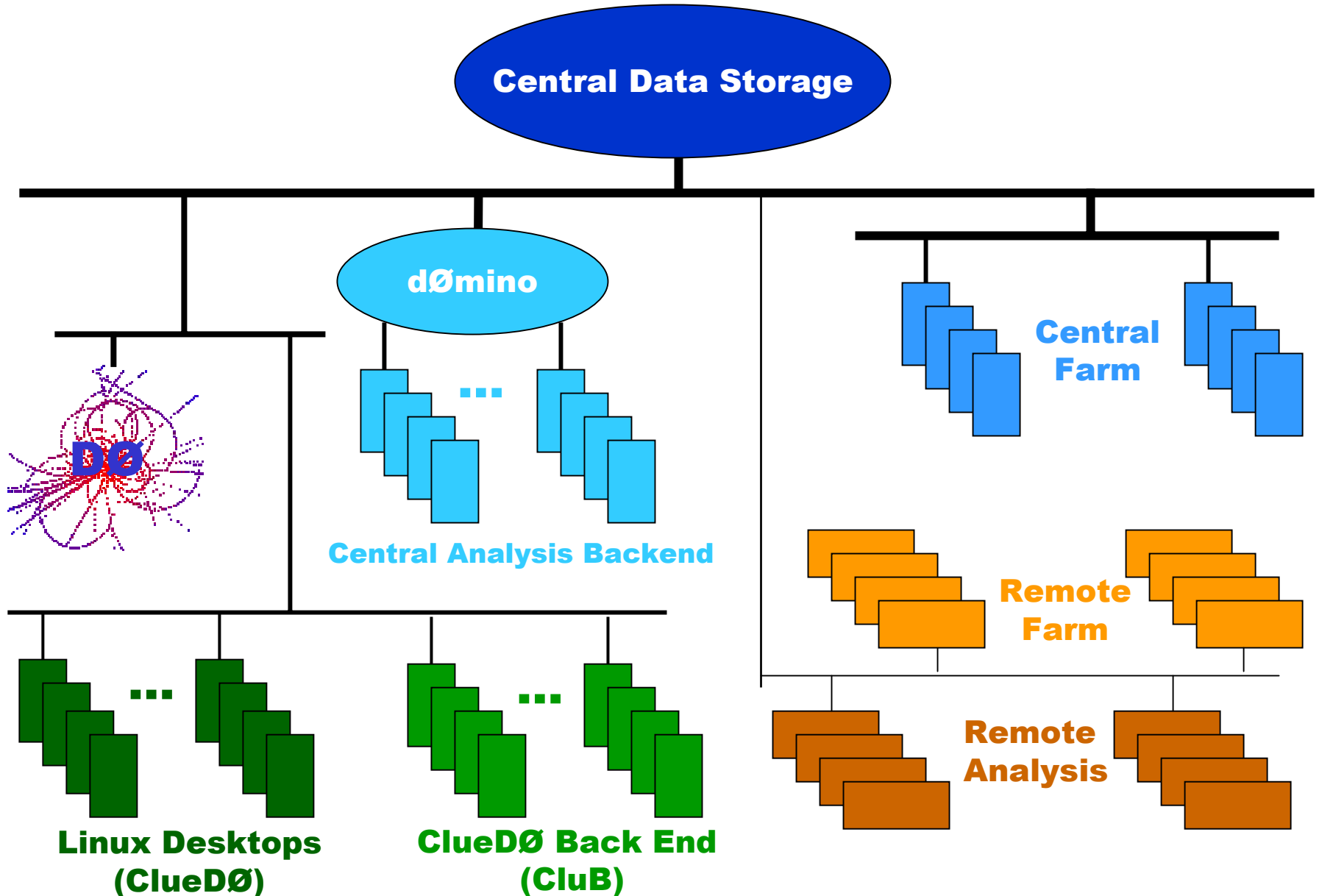
- **Central Analysis Backend (CAB) at Fermilab:**
A PC/Linux dØmino back-end supplied and administrated by the computing division
- **ClueDØ/CluB at DØ:**
Linux PCs contributed mostly by institutions for interactive and batch jobs.
- **Regional Analysis Centers (RAC):**
Institutions with CPU, disk and personnel resources to serve collaborators.

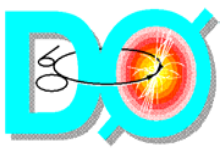
Layered Analysis Approach:

- **DST stripping:**
Resource intensive, limited to physics, and detector groups, done at CAB
- **TMB based:**
Medium resource required, expect to be done mostly by subgroups at RACs
- **Derived datasets:**
Individuals done daily on their desk/lap tops



Computing Architecture



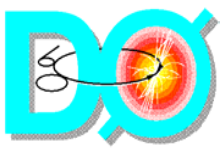


Where We Are Now

All building blocks are in place ...

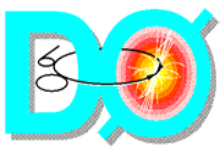
- **PC/Linux based Level-3 is taking a 500 Hz input and the DAQ is capable of writing at ~50 Hz.**
- **The offline reconstruction program (DØRECO) has all the basic reconstruction functionalities, is deployed at all farms, and writes DØRECO output in a temporary format.**
- **Data processing is done at Fermilab. The central farm is capable of processing event at ~12 Hz DC (20 sec/event on a 500 MHz processor) .**
- **Monte Carlo needs of physics analyses are met by remote farms (Czech R., France, G. Britain, Netherlands, USA)**
- **Geant-based (slow) and parameterized (fast) simulation programs exist and are being refined.**
- **Basic infrastructures and functionalities of data handling and access are in place. Data are stored in the Enstore system via SAM.**
- **Analysis CPUs are provided by an SGI O2000 system (dømino) and Linux desktops (ClueDØ, ...).**

... we are producing first physics results!



Where We Want to Go

- **An Level-3 capable of taking 1 kHz input and a DAQ capable of writing at ~50/100 Hz for Run IIa/IIb.**
- **A DØRECO running at a reasonable speed, writing out reconstructed information in both DST and TMB formats.**
- **A central Fermilab farm capable of keeping up with the online and providing some reprocessing CPU power.**
- **Simulation programs provide reasonable descriptions of real data.**
- **A reliable and fast data handling and access system capable of providing full TMB and partial DST datasets to all analysis centers.**
- **A global system capable of producing Monte Carlo events at $\frac{1}{2}$ of the data rate and providing secondary data processing.**
- **An analysis model of central and regional centers with sufficient CPU and disk resources to meet analysis needs.**
- **An automatic and tiered software release system serving all production and analysis centers as well as individual institutions.**
- ...



Summary

- **Fermilab provides the minimum need of DØ computing resources for physics analyses**
 - **limited (if any) CPU power for secondary data processing**
 - **no capability for the production of Monte Carlo events**
 - **bare minimum CPU resources for physics analyses**
- **Computing resources at collaborating institutions are critical to the timely analyses of DØ data. Regional analysis centers will**
 - **supplement the limited resources available at Fermilab**
 - **maximize intellectual output of the collaboration**
 - **potentially save on travel cost**

**Time has come
to bring data to physicists/students**